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SKETCH OF THE FLORA OF DEATH VALLEY, CALIFORNIA.[1]

BY FREDERICK VERNON COVILLE, WASHINGTON, D.C.

SINCE Death Valley, as shown by the published records of the Weather Bureau,[2] is the hottest and dryest area known in the United States, and probably in the world, and since the observations of the Death Valley Expedition showed that these extreme climatic conditions are reflected in its vegetable life, a description of this flora has an interest even greater than that incited by the average desert vegetation.

One not familiar with the Mohave and Colorado deserts must imagine broad stretches of treeless plains, out of which rise abrupt mountains, not covered with trees but exhibiting naked faces of rugged rocks with no covering of soil or lichens to conceal even their coloration. In the northern portion of the Mohave Desert region, in which Death Valley lies, the mountain ranges are closer together and the plain is cut up into narrow deep valleys trending in a general north and south direction. The deepest of these is Death Valley, its length about 175 miles, and its greatest breadth from peak to peak about 20 miles. The lowest portion of the valley is a moist plain about 40 miles long by 2 to 6 miles broad, gleaming with salt and alkali. Between this and the mountain faces are sloping gravelly mesas, at some parts of the valley 6 miles broad, at other points entirely absent. The mountains themselves are abrupt and naked, the Funeral Mountains on the east rising 7,000 feet, the Panamints on the west almost 11,000. Upon the crest of the Panamint range is an evergreen forest of pines and junipers.

The salt-flat in the bottom of the valley is quite devoid of vegetation, not because the moisture in the soil is too scant, but because it is so saturated with salt and alkaline compounds that no plant can live upon it.

The mesa bears a growth of scattered shrubs not sufficient, even at a distance, to conceal the ground between them. No larger plant is to be seen except at certain points where, along the line between the mesa and the salt-flat, the sub-soil is sufficiently moist to support the mesquite. This is a low, almost shrub-like, tree which commonly attains a height of 10 to 15 feet. This characteristic then, the absence of trees, may be taken as the most conspicuous feature of the Death Valley vegetation, as it is of the desert in general.

[1] In January, 1891, an expedition was sent out by the U. S. Department of Agriculture to explore the region of Death Valley, California, and to make a biological survey of it. About nine months were spent in the field, and the report, now nearly completed, will soon be published by the department. The general botanical features of the region, a full discussion of which will constitute a part of the final report, are here described by the botanist of the expedition.

[2] U. S. Department of Agriculture, Weather Bureau Bulletin No. 1, Notes on the Climate and Meteorology of Death Valley, California, by Mark W. Harrington. Washington, 1892.

The mesas bear, besides the shrubs, a large number of herbaceous plants which, although in late summer and in winter dead and barely noticeable, in the spring months of a rainy year come to be in some places really conspicuous. One of the desert sunflowers (*Encelia eriocephala*) was at one point so abundant that it even made the mesa appear yellow, at a distance, over an area many rods in extent. The general impression, however, of the traveller who is not a botanist is that the vegetation of the valley consists of clumps of mesquite set here and there along the edge of the salt flat, and a few scattered greasewood and creosote bushes on the mesa.

Not all parts of the mesa are, however, supplied with even so much plant life. At the mouth of Furnace Creek Cañon is a broad slope composed of mixed gravel, sand, and clay, a matrix capable, in some parts of the desert, of supporting a varied flora; but here for hundreds of yards is seen no plant whatever except one of the smallest greasewoods (*Atriplex hymenelytra*), its individuals growing far apart and attaining the height of barely a foot.

In still other portions of the mesa occurred a phenomenon which, if it is here interpreted rightly, is the best index that we have of the intense heat of this region. The higher portions of the mesa are cut up by the dry channels of the streams that follow mountain cloudbursts. Between these channels, which are called sometimes arroyas but oftener washes, are broad blocks of the mesa, whose surface has lain undisturbed for undoubtedly many thousands of years. The surface of the soil is covered closely with a layer of small, flat, water-worn stones which have accumulated on the top of the ground by the gradual washing out of their original clayey matrix. The erosion of the soil has undoubtedly been brought about by the slow agency of direct rainfall. The upper surfaces of the stones have a dark brown, almost black, color, and the dull lustre of a hard-burned brick. The coloration of these stones is ascribed to binoxide of manganese, produced by oxidation due to intense light acting during long periods of time[3]. These so-called sunburned areas in Death Valley bear no vegetation whatever. Even the two desert annuals, *Chorizanthe rigida* and *Chænactis attenuata*, which grow at other points in the hottest spots, are here wanting. The soil, a firm clayey one, is good, and the surface receives just as much rainfall as other parts of the valley. The phenomenon is explained by no hypothesis except that of intense heat, and a consideration of the evidence, in the absence of direct experiment, indicates that such a cause may be quite sufficient.

Experiments by Sachs upon active protoplasm have shown that when subjected to a temperature of 50° C. (122° F.) it ceases to carry on its functions, disintegration sets in, and death follows. But a plant may be situated in an atmosphere whose temperature is higher than this without itself attaining so great a heat; for two causes tend to reduce its temperature, the non-conductive nature of the tissues themselves, and the evaporation that characterizes transpiration. Yet even these sources of protection may be overridden by a still higher temperature. The well-known retention of vitality in the case of the spores of certain fungi after exposure to a temperature of even 212° F. does not indicate that a desert plant can endure a similar degree, for the protoplasm of the fungus spore is not in a state of activity, but that of a germinating or growing plant is.

The Weather Bureau tables, in the bulletin cited above, show five records of a temperature of 122° F. This is the temperature of air sheltered from the effects of radiation. The temperature of air exposed to ordinary conditions of radiation must be somewhat higher than this, and the temperature of gravel pebbles on the surface of the ground still higher; but, according to the principles of molecular physics, the black stones that have been described should reach a degree of heat decidedly greater than either of the other bodies. It is confidently believed that a temperature of from 140° to 150° F. is frequently attained under these conditions, and in such a temperature a growing plant would undoubtedly perish from heat.

That the flora of the valley may be more readily considered, all the species observed there have been arranged in groups. A review of these groups suggests some of the leading characteristics

[3] See Annual Report of the Wheeler Survey for 1876, pp. 178, 179.

of the flora. The whole number of species is 136. The group of paludose plants contains 48 names, of which 2 are trees, 6 shrubs, 32 perennials. and 8 annuals. These plants are not representative of the true arid flora of the valley, for they have in most cases an abundant supply of water. Comparatively few of these species are confined to the desert, many of them occur in the humid regions of intramontane California, several extend quite across the southern United States and Mexico, and a few are found throughout the subtropical region of the world. It is a general law, of which this part of the Death Valley flora is but a single example, that aquatic and paludose plants do not follow those laws of distribution which govern a true terrestrial flora.

The second group of plants constitutes the arid flora of the region. Of trees there are none, shrubs 20, perennials 18, and of annuals 50. Fourteen of the perennials are suffrutescent at base and carry on the functions of life throughout the year above ground. Three of the remaining four are grasses, the stems of which also retain some vitality through the winter. One plant only, *Cucurbita palmata*, is a true perennial, but it does not grow in the very arid parts of the valley, and comes almost in the category of moist-soil plants. Functionally, therefore, the arid flora of Death Valley is made up of shrubs and annuals. The reason for this state of affairs is found in the extreme heat and dryness of the climate, these being the two, or we may almost say the only, types of vegetation adapted to such conditions.

The geographic affinity of the arid flora of Death Valley is clear. A few species, such as *Mentzelia reflexa* and *Oxystylis lutea*, are known only in the immediate vicinity of the valley, but nearly all the others are common to the desert region of south-eastern California, Arizona, and north-western Mexico. The topographic position of Death Valley, as the deepest basin (480 feet below sea-level) in this desert area, renders the valley capable of supporting a vegetation belonging characteristically to the southern portion of the region. Several southern species, so far as the present data show, reach their northern limit in Death Valley.

The adaptive modifications of the flora are practically the same as those of the general vegetation of the surrounding desert, and will be discussed in considerable detail in the report of the expedition.

NOCTURNAL SONGSTERS, AND OTHER BIRD-NOTES.

BY ROBERT RIDGWAY, M.S., CURATOR OF THE DEPARTMENT OF BIRDS, U. S. NATIONAL MUSEUM.

DR. GIBBS'S interesting article on birds that sing in the night, in *Science* for Dec. 2, reminds me that much may yet be written on this subject. Some of our best songsters are unfortunately not represented in that portion of the country (Michigan) of which Dr. Gibbs writes; otherwise, his list of night-singers would not only have been considerably longer, but would have included at least two species, the mocking-bird and the yellow-breasted chat, that are every whit as notable as the nightingale itself. The night-singing habit of the mocking-bird is well known to all who are familiar with this "master of song." It is as much a characteristic of the bird as its powers of mimicry, for not all mocking-birds mimic, of which, however, more presently.

Next to the mocking-bird in this regard, though perhaps it would be better said equally with it, is the yellow-breasted chat, a bird remarkable for the oddity of its song rather than for its musical quality. Its notes are, however, loud and emphatic, and therefore are sure to attract attention whenever heard at night-time. Its nocturnal song — in no respect that I can discover different from that which it sings by day — has been familiar to me from boyhood, first in southern Illinois, then in California and other far-western States, latterly in Maryland and Virginia. A pair of chats live during summer close by my home (in a suburb of Washington), and few are the nights in May and June when the male does not sing, at more or less frequent intervals, the whole night through. I once thought that moonlight nights were particularly apt to excite birds to sing; but this particular chat kept no account of the almanac. His most brilliant performance, or at least the occasion which most compelled my interest, was during a specially dark night, when I purposely kept awake to make observations. From the time that darkness settled until 3 o'clock in the morning (when I shortly fell asleep) the longest interval between his songs was twenty minutes, but during the greater portion of the night he had scarcely finished one performance than another was begun.

Several others of our birds may properly be termed "habitual" night-singers. Here, about my home, I hear every night during the nesting season (unless it be storming) songs of the chipping sparrow, the field sparrow, the indigo bird, and the golden-crowned thrush, or oven bird; not merely once, but repeatedly. The night-song of the last-named bird is quite the same as that which John Burroughs says is the love-song; but I am puzzled to know whether at night, in the darkness, the singer launches from his high perch into the air, as is his habit during the waning light of daytime. I have heard the night-song of the oven bird so often and been so impressed with its exquisite though transient beauty, that I feel sure Burroughs was right when he suggested that Thoreau's "mysterious night-warbler" was really no new bird at all, but one he was otherwise familiar with; in short, was none other than the oven bird. Speaking of Burroughs, recalls an erroneous statement in one of his charming books ("Birds and Poets," p. 98). He says: "No bird can look our winters in the face and sing, as do many of the English birds." Surely had he passed a winter south of the parallel of 40° in the United States he could hardly have made this assertion. Here about Washington, and westward to beyond the Mississippi, the Carolina wren sings the winter long; and the colder, more crisp, the weather, if only the wind does not blow, the louder rings his powerful carol. So, also, does the tufted titmouse heed not the cold of winter, but bravely whistles his cheery tune of *pé to, pé to, pé to* — some would not call it a song, but it is loud and clear enough, and surely is no mere call-note. The cardinal, too, sings more or less all winter, and so do the white-throated and tree sparrows, though there are periods, caused doubtless by meteorological conditions, to us intangible, but of which the birds take note, when birds are little heard.

Among the many myths of popular bird-lore is that of the mocking-birds' habit of mimicry, of which a hint was given in a previous paragraph. In making this statement I would emphasize the word *habit*, as distinguished from the term faculty; since I would not for a moment deny this bird's ability (as a rule) to mimic far better than any other. The point is, that mimicry is not so much a habit of the mocking-bird as most people suppose. The reason for the popular error is very simple: The natural song of the mocking-bird is so varied, and is characterized by such wonderful compass, rapidity of change, and brilliancy of execution that persons not specially familiar with birds' notes naturally suppose the medley to be in large part borrowed; and the listener is further confirmed in this belief by the more or less frequent interpolation of what he recognizes as unquestionable imitations of the notes of other birds. Individual mocking-birds differ greatly in the character and quality of their songs, some being inveterate mimics while others seldom if ever spoil their own incomparable song by imitation. I recently possessed one of the best songsters of this species it was ever my pleasure to hear. His song was wholly his own; almost infinitely varied, wonderfully mellow and clear, bewildering in the rapidity of its changes, and surpassingly brilliant in execution. Yet, with all this, if any one of his notes suggested the note of any other bird I am sure it was not intentional.

Not only do birds' songs differ materially according to the individual, but often each individual possesses a more or less extensive *repertoire*, the separate parts or tunes of which are so different from one another that, heard without the singer being seen, they might readily be attributed to different birds. This is particularly true of the cardinal grosbeak; and I have not the slightest doubt some observers have received an unfavorable impression of this bird's song from having first, or perhaps only, heard one of the less attractive tunes of an individual which half an hour later might be singing a song totally different, and far finer. A pet cardinal, which I had for several years, sang six very distinct songs, besides minor variations. A remarkable peculiarity of this bird (though one which I believe to be characteristic of the species)